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(54) **Air conditioning system for vehicle**

Klimaanlagensystem für ein Fahrzeug
Système de climatisation pour véhicule

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(56) References cited:
DE-B3-102004 045 839 JP-A- 63 180 514
US-A1- 2006 289 458

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Description

BACKGROUND OF THE DISCLOSURE

5 Field of the Disclosure

[0001] The present invention relates to an air conditioning system for a vehicle which is capable of defogging a window glass.

10 Description of the Related Art

[0002] Japanese Patent Application Laid-Open No. 7-232549 discloses an air conditioning apparatus for a vehicle which is adapted to suppress occurrence of fogging on a window glass (in the specification, a front windshield glass and a door glass are generically called "a window glass") in accordance with humidity in a passenger compartment of the vehicle. This related art discloses that a fogging prevention determination value for determining whether or not a window glass is fogged is corrected in accordance with a rate of change in humidity in the passenger compartment in order to suppress occurrence of fogging on the window glass due to a delay in response of a humidity sensor upon a rapid rise in temperature in the passenger compartment. Patent Application US-A-2006/0289458 discloses an automotive vehicle defogging system according to the preamble of claims 1 and 9 to prevent dissipation of energy required to defog the automotive vehicle windshield. A surface temperature sensor mounted on the windshield detects the glass surface temperature. A humidity sensor spaced from the windshield glass by a predetermined distance detects the humidity around the windshield. A peripheral temperature sensor mounted inside from the windshield glass detects peripheral temperature around the glass. Dew point temperature is obtained in response to the detected humidity and a temperature value based on the temperatures detected by the surface and peripheral temperature sensors. The presence of fog is detected by comparing the dew point temperature with the surface temperature.

SUMMARY OF THE CLAIMED SUBJECT MATTER

[0003] In one aspect, the present disclosure relates to an air conditioning system for a vehicle, comprising a controller and a plurality of sensors in communication with the controller. The plurality of sensors include an interior temperature sensor for a vehicle interior, and an inner surface temperature sensor for a windshield. The controller is configured to determine a dew-point for the vehicle interior based on the sensed interior temperature and further configured to adjust the dew-point or the inner surface temperature based on a correction value. The controller performs a defogging operation when the inner surface temperature is less than the dew-point, wherein the dew-point or the inner surface temperature is adjusted value.

[0004] The means for correction may at least partially be based on the difference between the heat resistance of the windshield and the heat resistance of a vehicle door glass.

[0005] In an embodiment, the air conditioning system of a vehicle comprises: a controller and a plurality of sensors in communication with the controller, wherein the plurality of sensors includes an interior temperature sensor for a vehicle interior, a relative humidity sensor for the vehicle interior, and an inner surface temperature sensor for a windshield. The controller is configured to determine a dew-point for the vehicle interior based on the sensed interior temperature and the sensed relative humidity. The controller is further configured to adjust the dew-point based on a correction value and is further configured to perform a defogging operation when the inner surface temperature is less than the adjusted dew-point.

[0006] In another aspect, the present disclosure relates to an air conditioning system for a vehicle, comprising a controller and a plurality of sensors in communication with the controller. The plurality of sensors include a means for sensing a temperature of an interior of the vehicle, a means for sensing a relative humidity of the interior of the vehicle, and a means for sensing an inner surface temperature of a windshield of the vehicle. The controller is configured to determine a dew-point of the interior of the vehicle from the sensed interior temperature and the sensed relative humidity and further configured to adjust the dew-point using a means for correction. The controller performs a defogging operation when the sensed inner surface temperature is less than the adjusted dew-point.

[0007] In an embodiment of the present disclosure, the defogging operation may include at least one of: adjusting the vehicle interior temperature; changing an air conditioning mode to a defroster mode; increasing a rotational speed of a blower fan to increase an amount of output from a plurality of defroster vents; increasing a temperature of air blown from the plurality of defroster vents; changing an air flow configuration from recirculation to introduction of outside ambient air; and blowing dehumidified air out of the plurality of defroster vents.

[0008] In another aspect, the present disclosure relates to a method of defogging vehicle window glass. The method comprises: determining a temperature of a vehicle interior; determining a dew-point based on the determined temperature;

determining an inner surface temperature of a windshield; adjusting the dew-point or the inner surface temperature based on a correction value; comparing the inner surface temperature to the dew-point; and performing a defogging operation when the inner surface temperature is less than the dew-point, wherein the dew-point or the inner surface temperature is adjusted value.

5 [0009] The means for correction may at least partially be based on the difference between the heat resistance of the windshield and the heat resistance of a vehicle door glass.

BRIEF DESCRIPTION OF DRAWINGS

10 [0010] Features of the present disclosure will become more apparent from the following description in conjunction with the accompanying drawings.

[0011] Figure 1 is a schematic diagram illustrating a construction of an air conditioning system for a vehicle according to an exemplary embodiment of the present disclosure.

[0012] Figure 2 is a block diagram illustrating a control system of the air conditioning system shown in Figure 1.

15 [0013] Figure 3A is a diagram illustrating a layout of a sensor unit shown in Figure 2, and Figure 3B is a sectional view of the sensor unit along the line A-A of Figure 3A.

[0014] Figure 4 is a flowchart illustrating an operation of defogging according an exemplary embodiment of the present disclosure.

[0015] Figure 5 is a flowchart illustrating an operation to be performed after the flowchart shown in Figure 4.

20 [0016] Figure 6 is a flowchart illustrating an operation to be performed after the flowchart shown in Figure 5.

[0017] Figure 7 is a graph illustrating a relationship between predetermined time T_s and temperature T_{am} of an outside ambient air which may be used in step S17, as shown in Figure 5.

DETAILED DESCRIPTION

25 [0018] A construction and operation of an air conditioning system for a vehicle according to an exemplary embodiment of the present disclosure will be explained hereinafter by referring to the accompanying drawings.

[Construction of air conditioning system for a vehicle]

30 [0019] In vehicular air conditioning system 1 blower fan 2 may be rotated and an inside air (recirculated air) or an outside air (fresh air) may be sucked into air conditioning unit 3 through inside/outside air (recirculation/fresh air) switching door **D1**. A pressurized refrigerant may be transmitted to evaporator 4 by driving compressor 12 (see Figure 2), and the air sucked into air conditioning unit 3 may pass through evaporator 4 to thereby be dehumidified and cooled. The air passing through evaporator 4 may be divided into a part thereof which may pass through heater core 5 to thereby be heated, and the remaining part thereof which may bypass heater core 5 in the cooled condition, at a ratio according to an opening of air-mix door **D2**. The part that may pass through heater core 5 and the remaining part that may bypass heater core 5 may be mixed with each other downstream from heater core 5, so that an air-conditioned wind may be generated. The air-conditioned wind may be blown from a vent outlet port, a defroster outlet port, or a foot outlet port which may be exposed to an inside of a passenger compartment of the vehicle, via vent door **D3**, defroster door **D4**, and foot door **D5**, respectively, which may be opened and closed in accordance with a plurality of air conditioning modes.

35 [0020] In a vent mode, a defroster mode, and a foot mode, vent door **D3**, defroster door **D4**, or foot door **D5** may be opened, respectively. In a bilevel mode, vent door **D3** and foot door **D5** may be opened. In a def-foot mode, defroster door **D4** and foot door **D5** may be opened. Blower fan 2 and respective doors **D1** to **D5** may be driven by actuator 13 (see Figure 2), which may be a motor. A windshield defroster outlet port (a front defroster) may be disposed on an upper surface of an instrument panel near a lower end portion of front windshield glass 17 along a width direction of the vehicle. Blowing of the air-conditioned wind from the windshield defroster outlet port may remove fogging of front windshield glass 17. Further, a side defroster outlet port (a side defroster) may be disposed at both end portions of the instrument panel in the width direction of the vehicle and may blow the air-conditioned wind toward a door glass.

50 [Construction of control system]

[0021] The control system for controlling vehicular air conditioning system 1 may include sensor unit 11, compressor 12, actuator 13, coolant temperature sensor 14, outside ambient air temperature sensor 15 all in communication with controller 16, as shown in Figure 2. As shown in Figures 3A and 3B, sensor unit 11 may, preferably, be disposed in a position on an inside surface of front windshield glass 17 which may be apart from the defroster outlet ports (at a lower side of the windshield) as far as possible and may be allowed to be free from exposure to the defroster wind. For example, sensor unit 11 may be mounted to a portion of front windshield glass 17 which may be in the middle in the width direction

of the vehicle and near a mounting site of rearview mirror 18 at an upper end portion of front windshield glass 17. As shown in Figure 3B, sensor unit 11 may include temperature sensor 19a that may detect temperature **T_{ga}** of vehicle inside air in the vicinity of front windshield glass 17, temperature sensor 19b that may detect temperature **T_g** of an inner surface of front windshield glass 17, and humidity sensor 20 that may detect humidity **RH** of the vehicle inside air in the vicinity of front windshield glass 17. Sensor unit 11 may include additional sensors and may also be located anywhere within the passenger compartment of the vehicle. Additionally, the sensors may be located throughout the passenger compartment, but may not be in a single sensor unit 11, but may be in multiple sensor units.

[0022] Temperature sensors 19a and 19b and humidity sensor 20 may be disposed on an inside of generally box-shaped body 21. Holes 22, which may be provided for introducing the inside air to the sensor elements, may be formed in an upper surface of box-shaped body 21. Box-shaped body 21 may have an elastic resin film 23 on a bottom surface thereof, to which temperature sensor 19b may be fixed. Temperature sensors 19a and 19b may both, preferably, be constituted of thermistors, but may also be any means of measuring temperature. Temperature sensors 19a and 19b and humidity sensor 20 may output signals to controller 16 via a harness (not shown).

[0023] Additional sensors located throughout the vehicle may also be in communication with controller 16. For example, coolant temperature sensor 14 may detect engine coolant temperature **T_w** in the vehicle, and outside ambient air temperature sensor 15 may detect temperature **T_{am}** of ambient air outside of the vehicle. Additionally, vehicle speed sensor 24 may detect the speed of the vehicle and may output a value indicative of the detected vehicle speed to controller 16.

[0024] Signals from the plurality of sensors, including coolant temperature sensor 14, outside ambient air temperature sensor 15, temperature sensors 19a and 19b, and humidity sensor 20 may be input to controller 16. Controller 16 may perform processing, as described later, based on the signals from these sensors and may output control signals to compressor 12 and actuator 13.

[0025] Controller 16 may include a timer or clock, a memory for storing values output from the plurality of sensors and predetermined values, and a processor to calculate rates and compare values.

[0026] Further, controller 16 may receive other signals necessary for air conditioning control. For example, signals from a solar radiation sensor for detecting an amount of solar radiation, an air intake temperature sensor for detecting an air intake temperature of the air after passing through evaporator 4, and a setting device for setting a target temperature in the passenger compartment. Illustrations and further discussion of these sensors and device, or any other sensors and devices, are omitted, but may be incorporated into the air conditioning system described herein.

[Defogging operation]

[0027] The thus constructed vehicular air conditioning system 1 may suppress fogging of a window glass (particularly, a door glass) due to change in the outside air temperature by performing the following defogging operation, explained by referring to the flowcharts shown in Figures 4-6. The flowcharts shown in Figures 4-6 illustrate a routine of the defogging operation which may be repeatedly performed by controller 16 at predetermined intervals.

[0028] A description of a vehicle being first turned on is described below. However, the process as described may be continuously operated to perform the defogging operation during operation of the vehicle.

[0029] In the flowchart shown in Figure 4, the routine may be started at the time (t=0) when an ignition switch of the vehicle is turned from the OFF state to the ON state (that is, at the time of start-up of the vehicle).

[0030] In step **S1** controller 16 may detect engine coolant temperature **T_w(t)** through coolant temperature sensor 14. In step **S2**, controller 16 may detect inner surface temperature **T_g(t)** of front windshield glass 17 through temperature sensor 19b. In step **S3**, controller 16 may detect inside air temperature **T_{ga}(t)** in the vicinity of front windshield glass 17 through temperature sensor 19a. In step **S4**, controller 16 may detect relative humidity **RH(t)** of the inside air in the vicinity of front windshield glass 17 through humidity sensor 20. In step **S5**, controller 16 may detect temperature **T_{am}(t)** of ambient air outside of the vehicle through outside air temperature sensor 15. In step **S6**, controller 16 may calculate dew-point temperature **T_d(t)** in the vicinity of front windshield glass 17 by using the following mathematical expression:

$$T_d(t) = \frac{4075.16}{18.75 - \ln \left(\frac{RH(t)}{100} e^{\frac{18.75 - \frac{4075.16}{T_{ga}(t) + 236.52}}{}} \right)} - 236.52 .$$

[0031] In steps S1-S6, variable t is a time when the process is executed. Throughout the operation of the vehicle the process may be executed n times. The operation may be executed at any time interval, for example, every 0.5 seconds.

[0032] In step **S11**, controller 16 may determine whether or not engine coolant temperature **T_w(t)** detected in step **S1**

may be less than predetermined temperature **A**. As a result of the determination, in a case where engine coolant temperature $T_w(t)$ may be less than predetermined engine coolant temperature **A**, controller 16 may determine that a period of time during which the vehicle may be in the OFF state may be long and there may be a high possibility that a temperature difference between the front window glass and the door glass may be increased. The routine may then proceed to step **S12**. On the other hand, in a case where engine coolant temperature $T_w(t)$ may be greater than predetermined temperature **A**, controller 16 may determine that the period of time during which the vehicle may be in the OFF state may be short and there may be a low possibility that the temperature difference between the front window glass and the door glass may be increased. The routine may then proceed to step **S18**. Further, if the vehicle is already in the ON state, the controller 16 may determine that $T_w(t)$ is greater than predetermined engine coolant temperature **A**. In this case, the routine may proceed to step **S18**.

[0033] Although in this embodiment, controller 16 may detect the engine coolant temperature in order to determine a length of the period of time during which the vehicle may be in the OFF state, controller 16 may determine the length of the period of time during which the vehicle may be in the OFF state by using other methods such as actual measurement of the period of time during which the vehicle may be in the stopped state, which may be determined by the timer or clock of controller 16, or by an independent timer or clock. In this case, controller 16 may determine if the vehicle has been in the OFF state for a predetermined time. If it is greater than a predetermined time, then the routine may proceed to step **S12**. However, if it is less than a predetermined time, then the routine may proceed to step **S18**.

[0034] In step **S12**, controller 16 may determine whether or not vehicle speed V may be greater than predetermined speed **B**, and thereby may determine whether or not the vehicle may be started to shift from a stopped state to a moving state. At a time when vehicle speed V may become greater than predetermined speed **B**, controller 16 may determine that the vehicle may be started to shift from the stopped state to the moving state and proceed to step **S13**.

[0035] In step **S13**, controller 16 may determine a rate of change in the ambient air outside of the vehicle. The rate may be obtained by dividing the difference between a current detected temperature value and a previous detected temperature value by a time interval between the previous detection and the current detection. Specifically, outside ambient air temperature value $T_{am}(n-1)$ of the ambient air outside of the vehicle, which may have been detected in a previous processing in step **S5**, and outside ambient air temperature value $T_{am}(n)$ of the ambient air outside of the vehicle, which may have been detected in a current processing in step **S5**, are compared. In this calculation, n is the current processing operation. This difference is then divided by the time interval between temperature measurements. Controller 16 may then compare the rate of change of the ambient air outside the vehicle with a predetermined value **C**. As a result of the determination, in a case where the rate of change may be greater than predetermined rate **C**, controller 16 may proceed to the processing in step **S14**. On the other hand, in a case where the rate of change may be less than predetermined value **C**, controller 16 may proceed to the processing in step **S18**.

[0036] In step **S14**, controller 16 may determine a rate of change in the inner surface temperature of front windshield 17. The rate may be obtained by dividing the difference between a current detected temperature value and a previous detected temperature value by a time interval between the previous detection and the current detection. Specifically, inner surface temperature value $T_g(n-1)$ of front windshield glass 17, which may have been detected in a previous processing in step **S2**, and inner surface temperature value $T_g(n)$ of front windshield glass 17, which may have been detected in a current processing in step **S2**, are compared. This difference is then divided by the time interval between temperature measurements. Controller 16 may then compare the rate of change of the inner surface temperature with a predetermined value **D**. As a result of the determination, in a case where the rate of change may be greater than predetermined value **D**, controller 16 may proceed to the processing in step **S15**. On the other hand, in a case where the rate of change may be less than predetermined value **D**, controller 16 may proceed to the processing in step **S18**.

[0037] In step **S15**, controller 16 may set correction value β for a fogging prevention determination value to predetermined value **X**, where **X** is non-zero. The predetermined value **X** may be preset in controller 16 and may be determined based on a difference in heat resistance between front windshield glass 17 and the door glass.

[0038] Following step **S15**, the process may proceed to begin the process designated in Figure 6. Additionally, in step **S16**, controller 16 may switch the timer of controller 16, for counting an elapsed time (count value), from the OFF state to the ON state.

[0039] In step **S17**, controller 16 may determine whether or not a count value **T** of the timer may be greater than predetermined value **Ts**. Predetermined value **Ts** may be a value that may be decreased with an increase in temperature $T_{am}(t)$ of the ambient air outside of the vehicle and may be set and adjusted by controller 16 accordingly, as illustrated in Figure 7.

[0040] When count value **T** of the timer is greater than predetermined value **Ts**, controller 16 may proceed to the processing in step **S18**. In other words, **S18** is processed when the time to reach predetermined time **Ts** may have elapsed since controller 16 set correction value β for the fogging prevention determination value to predetermined value **X**. In a case where it may be determined that predetermined time **Ts** may not have elapsed, controller 16 may proceed to the processing as detailed in Figure 6, as detailed below.

[0041] In step **S18**, controller 16 may set correction value β for the fogging prevention determination value to zero.

The process may then proceed to the procedure as shown in Figure 6.

[0042] In step **S21**, controller 16 may compare inner surface temperature **Tg(t)** of front windshield glass 17, which may have been detected in step **S2**, with a threshold fogging prevention determination value. The threshold fogging prevention determination value may be obtained by adding correction value β to dew-point temperature **Td(t)** calculated in step **S6**. Controller 16 may then determine whether or not inner surface temperature **Tg(t)** of front windshield glass 17 may be less than the threshold fogging prevention determination value. In a case where inner surface temperature **Tg(t)** of front windshield glass 17 may be less than the threshold fogging prevention determination value controller 16 may proceed to the processing in step **S22**. On the other hand, in a case where inner surface temperature **Tg(t)** of front windshield glass 17 may be greater than the threshold fogging prevention determination value controller 16 may proceed to the processing in step **S24**.

[0043] In step **S22**, controller 16 may determine that there may be a possibility of fogging of the window glass and may set a fogging determination flag to the ON state.

[0044] In step **S23**, controller 16 may output a control signal to either one or both of compressor 12 and actuator 13 and may perform such an air conditioning operation as to defog the window glass (i.e., a defogging operation). Specifically, fogging on the window glass may be removed by decreasing the dew-point temperature near the inner surface of the window glass by blowing a dehumidified air across the window glass, or by increasing the outer surface temperature of the window glass by blowing out an air having a relatively high temperature across the window glass. Therefore, controller 16 may perform any one of the following operations (a)-(e) or any combination thereof, during step **S23**:

(a) change the air conditioning mode to the mode which allows air blowing from the defroster outlet port (i.e, defroster mode or def-foot mode);

(b) increase an amount of the defroster output by increasing a rotational speed of blower fan 2;

(c) increase a temperature of the air blown from the defroster outlet port by regulating the opening of the air-mix door **D2**;

(d) in a case where inside air recirculation is conducted, shift from the inside air recirculation to outside (fresh) air introduction by operation of inside/outside air switching door **D1**; and

(e) blow dehumidified air by turning on compressor 12.

[0045] After step **S23** is complete, the process may return to step **S17** to determine if count value **T** of the timer is greater than predetermined value **Ts**. If the count value **T** is still less than predetermined time **Ts**, then the process repeats the steps of Figure 6. However, if the count value **T** is greater than predetermined time **Ts**, then correction value β is set to zero and the steps of Figure 6 may be completed for a final processing.

[0046] If, however, it is determined that inner surface temperature **Tg(t)** of front windshield glass 17 may be greater than the threshold fogging prevention determination value controller 16 may proceed to the processing in step **S24**. Controller 16 may determine that there may be no possibility of occurrence of fogging on the window glass, and may set the fogging determination flag to the OFF state.

[0047] In step **S25**, controller 16 may output control signals to compressor 12 and actuator 13 and may stop the defogging operation if the fogging determination flag was previously set to the ON state. Or, alternatively, if the defogging operation was previously set to the OFF state, the fogging determination flag may remain in the OFF state.

[0048] Advantageously, as may be understood from the above explanation, under the defogging operation of this disclosure, controller 16 may determine whether or not temperature **Tam** of the outside air of the vehicle may be decreased by a value greater than the predetermined value. In a case where it may be determined that temperature **Tam** of the outside air of the vehicle may be decreased by a value greater than the predetermined value, controller 16 may set fogging prevention determination value **Td** + β so as to determine earlier that there may be a possibility of occurrence of fogging on the window glass. As a result, it may be possible to suppress fogging of the window glass with a change in temperature **Tam** of the outside air of the vehicle and ensure visibility.

[0049] Further, under the defogging operation in this exemplary embodiment, controller 16 may determine whether or not temperature **Tam** of the ambient air outside of the vehicle may be decreased by the value greater than the predetermined value when the vehicle may be started to shift from a stopped state to a running state. As a result, it may be possible to suppress occurrence of such an error that the defogging operation may be started in response to a drop in the ambient air temperature outside the vehicle which may-be caused by operation of a radiator cooling fan during idling of the vehicle.

[0050] Further, under the defogging operation as described herein, controller 16 may set the fogging prevention determination value by adding correction value β , which may be determined on the basis of a difference in heat resistance

between the front windshield glass and the door glass of the vehicle, to the determined dew-point value. As a result, it may be possible to suppress fogging of the door glass that may be disposed within a visibility region of the side mirror and may tend to undergo the fogging, preceding fogging of the front windshield glass.

5 [0051] Further, under the defogging operation as described herein, in a case where a rate of change (a rate of decrease) in inner surface temperature $T_g(t)$ of front windshield glass 17 may be greater than a predetermined value, controller 16 may correct the fogging prevention determination value. Therefore, it may be possible to suppress an error in determination of fogging.

10 [0052] Further, under the defogging operation as described herein, in a case where it may be determined that the engine coolant temperature may be less than a predetermined temperature, controller 16 may determine whether or not the temperature of the ambient air outside of the vehicle may be decreased by the value greater than the predetermined value. Therefore, it may be possible to suppress an error in determination of fogging.

15 [0053] Further, under the defogging operation as described herein, controller 16 may reset the fogging prevention determination value to a value in the ordinary state in response to lapse of predetermined time T_s that may be set in accordance with temperature T_{am} of the outside air of the vehicle. In general, as temperature T_{am} of the ambient air outside of the vehicle may become lower, the time that may be taken to achieve a convergence of the temperature difference between the front windshield glass and the door glass in the vehicle running state and a convergence of the temperature difference between the front windshield glass and the door glass in the vehicle stopped state may be increased. Therefore, due to the above defogging operation as described herein, a correction time may be appropriately set to thereby suppress erroneous determination of occurrence of fogging.

20 [0054] Modifications and variations of the embodiment described above may occur to those skilled in the art in light of the above disclosure. For instance, correction value β may be subtracted from detected inner surface temperature $T_g(t)$ instead of being added to dew-point temperature $T_d(t)$ (threshold value of fogging prevention determination). Due to such a correction, the presence of a possibility of occurrence of fogging on the window glass may be determined earlier.

25 [0055] Further, one skilled in the art may recognize modifications of the present operation, such as omitting the steps of determining the engine coolant temperature or the vehicle speed, without deviating from the scope of the present disclosure.

30 [0056] Additionally, as noted above, this system advantageously allows a vehicle to prevent fogging of windows prior to impairment of visibility to a driver. The system allows for operation during initial start-up of the vehicle, and may be effective when driving a vehicle from a garage into the open air, where a sudden temperature difference may be present, so that fogging of windows may occur. Further, the present system may be effective when a driver is operating a vehicle in a tunnel, and after leaving the tunnel, there is a sudden change in the temperature so that fogging of windows may occur. Further, the present system may be effective when a driver experiences a sudden change in the weather, wherein fogging of the windows may occur due to changes in the temperature or humidity conditions.

35 [0057] While the disclosure has been presented with respect to a limited number of embodiments, those skilled in the art, having benefit of this disclosure, will appreciate that other embodiments may be devised which do not depart from the scope of the present disclosure. Accordingly, the scope of the invention should be limited only by the attached claims.

40 Claims

1. An air conditioning system (1) of a vehicle, comprising:

a controller (16); and

a plurality of sensors in communication with the controller, wherein;

45 the plurality of sensors includes an interior temperature sensor (19a) for a vehicle interior, and an inner surface temperature sensor (19b) for a windshield (17),

the controller (16) is configured to determine a dew-point for the vehicle interior based on the sensed interior temperature,

50 the controller (16) is further configured to adjust the dew-point or the inner surface temperature based on a correction value,

the controller (16) is further configured to perform a defogging operation when the inner surface temperature is less than the dew-point, wherein the dew-point or the inner surface temperature is adjusted value, and

55 **characterized in that** the correction value is based on the difference between a heat resistance of the windshield (17) and a heat resistance of a vehicle door glass.

2. The air conditioning system of a vehicle of claim 1, wherein:

the plurality of sensors includes an outside temperature sensor (15) for an outside ambient air, the controller (16) is further configured to determine a rate of change of the outside temperature, and the controller (16) is further configured to perform the adjusting the dew-point or the inner surface temperature when the determined rate of change of the outside temperature is greater than a predetermined outside temperature value.

- 5
3. The air conditioning system of a vehicle of claim 1, wherein the defogging operation comprises at least one of:

adjusting the vehicle interior temperature;
changing an air conditioning mode to a defroster mode;
10 increasing a rotational speed of a blower fan to increase an amount of output from a plurality of defroster vents;
increasing a temperature of air blown from the plurality of defroster vents;
changing an air flow configuration from recirculation to introduction of outside ambient air; and
blowing dehumidified air out of the plurality of defroster vents.

- 15
4. The air conditioning system of a vehicle of claim 1, wherein:

the plurality of sensors includes a vehicle speed sensor (24),
the controller (16) is further configured to determine if the vehicle is in a stopped state or a moving state based
20 on the vehicle speed, and
the controller (16) is further configured to determine whether the inner surface temperature is less than the adjusted dew-point when the vehicle is shifted from the stopped state to the moving state.

- 25
5. The air conditioning system of a vehicle of claim 1, wherein:

the controller (16) is further configured to determine a rate of change of the interior temperature, and
the controller (16) is further configured to adjust the correction value when the determined rate of change of the
vehicle interior temperature is greater than a predetermined vehicle interior value.

- 30
6. The air conditioning system of a vehicle of claim 1, wherein:

the plurality of sensors includes an engine coolant temperature sensor (14), and
the controller (16) is further configured to determine whether the inner surface temperature is less than the
adjusted dew-point when the sensed engine coolant temperature is less than a predetermined engine coolant
35 value.

7. The air conditioning system of a vehicle of claim 1, wherein:

the controller (16) is further configured to count time, and
40 the controller (16) stops adjusting the dew-point when a predetermined time has elapsed.

8. The air conditioning system of a vehicle of claim 7, wherein the controller (16) decreases the predetermined time as the outside ambient air temperature increases.

- 45
9. A method to defog vehicle window glass, the method comprising:

determining a temperature of a vehicle interior;
determining a dew-point based on the determined temperature of the vehicle interior;
determining an inner surface temperature of a windshield (17);
50 adjusting the dew-point or the inner surface temperature based on a correction value;
comparing the inner surface temperature to the dew-point;
performing a defogging operation when the inner surface temperature is less than the dew-point, wherein the dew-point or the inner surface temperature is adjusted value; and.

55 **characterized in that** the correction value is based at least partially on a difference between a heat resistance of the windshield (16) and a heat resistance of a vehicle door glass.

10. The method to defog vehicle window glass of claim 9, wherein the defogging operation comprises at least one of:

adjusting the temperature of the vehicle interior;
changing an air conditioning mode to a defroster mode;
increasing a rotational speed of a blower fan to increase an amount of output from a plurality of defroster vents;
increasing a temperature of air blown from the plurality of defroster vents;
5 changing an air flow configuration from recirculation to introduction of outside ambient air; and
blowing dehumidified air out of the plurality of defroster vents.

Patentansprüche

1. Klimaanlage (1) eines Fahrzeugs, umfassend:

eine Steuerung (16); und
mehrere Sensoren, die mit der Steuerung in Kommunikation stehen, wobei:

die mehreren Sensoren einen Innenraumtemperatursensor (19a) für einen Fahrzeuginnenraum und einen
Innenflächentemperatursensor (19b) für eine Windschutzscheibe (17) umfassen,
die Steuerung (16) konfiguriert ist, um auf der Grundlage der detektierten Innenraumtemperatur einen
Taupunkt für den Fahrzeuginnenraum zu bestimmen,
20 die Steuerung (16) ferner konfiguriert ist, um den Taupunkt oder die Innenflächentemperatur auf der Grund-
lage eines Korrekturwerts einzustellen,
die Steuerung (16) ferner konfiguriert ist, um einen Beschlagentfernungsvorgang durchzuführen, wenn die
Innenflächentemperatur kleiner als der Taupunkt ist, wobei der Taupunkt oder die Innenflächentemperatur
ein eingestellter Wert ist, und
25 **dadurch gekennzeichnet, dass** der Korrekturwert auf der Differenz zwischen einem Wärmewiderstand
der Windschutzscheibe (17) und einem Wärmewiderstand eines Fahrzeugtürglases beruht.

2. Klimaanlage eines Fahrzeugs gemäß Anspruch 1, wobei:

30 die mehreren Sensoren einen Außentemperatursensor (15) für eine Außenumgebungsluft umfassen,
die Steuerung (16) ferner konfiguriert ist, um eine Änderungsrate der Außentemperatur zu bestimmen, und
die Steuerung (16) ferner konfiguriert ist, um das Einstellen des Taupunkts oder der Innenflächentemperatur
durchzuführen, wenn die bestimmte Änderungsrate der Außentemperatur größer als ein vorgegebener Außen-
temperaturwert ist.

3. Klimaanlage eines Fahrzeugs gemäß Anspruch 1, wobei der Beschlagentfernungsvorgang mindestens einen der folgenden Schritte umfasst:

Einstellen der Fahrzeuginnenraumtemperatur;
40 Ändern eines Klimatisiermodus in einen Entfrostermodus;
Erhöhen einer Drehzahl eines Gebläses, um eine Ausstoßmenge von mehreren Entfrosterdüsen zu erhöhen;
Erhöhen einer Temperatur der Luft, die von den mehreren Entfrosterdüsen ausgeblasen wird;
Ändern einer Luftstromkonfiguration von Umluft auf Einleitung von Außenumgebungsluft; und
Blasen von entfeuchteter Luft aus den mehreren Entfrosterdüsen.

4. Klimaanlage eines Fahrzeugs gemäß Anspruch 1, wobei:

die mehreren Sensoren einen Fahrzeuggeschwindigkeitssensor (24) umfassen,
die Steuerung (16) ferner konfiguriert ist, um auf der Grundlage der Fahrzeuggeschwindigkeit zu bestimmen,
50 ob sich das Fahrzeug in einem angehaltenen Zustand oder einem bewegten Zustand befindet, und
die Steuerung (16) ferner konfiguriert ist, um zu bestimmen, ob die Innenflächentemperatur kleiner als der
eingestellte Taupunkt ist, wenn das Fahrzeug von dem angehaltenen Zustand in den bewegten Zustand gebracht
wird.

5. Klimaanlage eines Fahrzeugs gemäß Anspruch 1, wobei:

die Steuerung (16) ferner konfiguriert ist, um eine Änderungsrate der Innenraumtemperatur zu bestimmen, und
die Steuerung (16) ferner konfiguriert ist, um den Korrekturwert einzustellen, wenn die bestimmte Änderungsrate

der Fahrzeuginnenraumtemperatur größer als ein vorgegebener Fahrzeuginnenraumwert ist.

6. Klimaanlage eines Fahrzeugs gemäß Anspruch 1, wobei:

5 die mehreren Sensoren einen Motorkühlmitteltemperatursensor (14) umfassen, und die Steuerung (16) ferner konfiguriert ist, um zu bestimmen, ob die Innenflächentemperatur kleiner als der eingestellte Taupunkt ist, wenn die detektierte Motorkühlmitteltemperatur kleiner als ein vorgegebener Motorkühlmittelwert ist.

10 7. Klimaanlage eines Fahrzeugs gemäß Anspruch 1, wobei:

die Steuerung (16) ferner konfiguriert ist, um Zeit zu messen, und die Steuerung (16) aufhört, den Taupunkt einzustellen, wenn ein vorgegebener Zeitraum abgelaufen ist.

15 8. Klimaanlage eines Fahrzeugs gemäß Anspruch 7, wobei die Steuerung (16) den vorgegebenen Zeitraum mit Zunehmen der Außenumgebungslufttemperatur verringert.

9. Verfahren zur Beschlagentfernung auf Fahrzeugfensterglas, wobei das Verfahren umfasst:

20 Bestimmen einer Temperatur eines Fahrzeuginnenraums;
Bestimmen eines Taupunkts auf der Grundlage der bestimmten Temperatur des Fahrzeuginnenraums;
Bestimmen einer Innenflächentemperatur einer Windschutzscheibe (17);
Einstellen des Taupunkts oder der Innenflächentemperatur auf der Grundlage eines Korrekturwerts;
Vergleichen der Innenflächentemperatur mit dem Taupunkt;
25 Durchführen eines Beschlagentfernungsvorgangs, wenn die Innenflächentemperatur kleiner als der Taupunkt ist, wobei der Taupunkt oder die Innenflächentemperatur ein eingestellter Wert ist; und
dadurch gekennzeichnet, dass der Korrekturwert mindestens teilweise auf einer Differenz zwischen einem Wärmewiderstand der Windschutzscheibe (16) und einem Wärmewiderstand eines Fahrzeugtürglases beruht.

30 10. Verfahren zur Beschlagentfernung auf Fahrzeugfensterglas gemäß Anspruch 9, wobei der Beschlagentfernungsvorgang mindestens einen der folgenden Schritte umfasst:

Einstellen der Temperatur des Fahrzeuginnenraums;
Ändern eines Klimatisiermodus in einen Entfrostermodus;
35 Erhöhen einer Drehzahl eines Gebläses, um eine Ausstoßmenge von mehreren Entfrosterdüsen zu erhöhen;
Erhöhen einer Temperatur der Luft, die von den mehreren Entfrosterdüsen ausgeblasen wird;
Ändern einer Luftstromkonfiguration von Umluft auf Einleitung von Außenumgebungsluft; und
Blasen von entfeuchteter Luft aus den mehreren Entfrosterdüsen.

40

Revendications

1. Système d'air conditionné (1) d'un véhicule, comprenant :

45 un contrôleur (16) ; et
une pluralité de capteurs en communication avec le contrôleur, dans lequel ;
la pluralité de capteurs inclut un capteur de température intérieure (19a) pour un intérieur de véhicule, et un capteur de température de surface intérieure (19b) pour un pare-brise (17),
le contrôleur (16) est configuré pour déterminer un point de rosée pour l'intérieur du véhicule sur la base de la
50 température intérieure détectée,
le contrôleur (16) est en outre configuré afin d'ajuster le point de rosée ou la température de surface intérieure sur la base d'une valeur de correction,
le contrôleur (16) est en outre configuré afin d'effectuer une opération de désembuage quand la température de surface intérieure est inférieure au point de rosée, dans lequel le point de rosée ou la température de surface intérieure est une valeur ajustée, et
55 **caractérisé en ce que** la valeur de correction est basée sur la différence entre une résistance thermique du pare-brise (17) et une résistance thermique d'une vitre de porte de véhicule.

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2. Système d'air conditionné d'un véhicule selon la revendication 1, dans lequel :

la pluralité de capteurs inclut un capteur de température extérieure (15) pour un air ambiant extérieur, le contrôleur (16) est en outre configuré afin de déterminer un taux de variation de la température extérieure, et le contrôleur (16) est en outre configuré afin d'effectuer l'ajustement du point de rosée ou de la température de surface intérieure quand le taux de variation déterminé de la température extérieure est supérieur à une valeur de température extérieure prédéterminée.

3. Système d'air conditionné d'un véhicule selon la revendication 1, dans lequel l'opération de désembuage comprend au moins une étape consistant à :

ajuster la température intérieure du véhicule ;
changer un mode de conditionnement d'air en un mode de dégivreur ;
augmenter une vitesse de rotation d'un ventilateur de soufflerie pour augmenter une quantité de rendement provenant d'une pluralité d'événements de dégivreur ;
augmenter une température d'air soufflé depuis la pluralité d'événements de dégivreur ;
changer une configuration d'écoulement d'air de la recirculation à l'introduction d'air ambiant extérieur ; et souffler de l'air déshumidifié hors de la pluralité d'événements de dégivreur.

4. Système d'air conditionné d'un véhicule selon la revendication 1, dans lequel :

la pluralité de capteurs inclut un capteur de vitesse de véhicule (24), le contrôleur (16) est en outre configuré pour déterminer si le véhicule est dans un état arrêté ou un état en mouvement sur la base de la vitesse du véhicule, et le contrôleur (16) est en outre configuré afin de déterminer si la température de surface intérieure est inférieure au point de rosée ajusté quand le véhicule passe de l'état arrêté à l'état en mouvement.

5. Système d'air conditionné d'un véhicule selon la revendication 1, dans lequel :

le contrôleur (16) est en outre configuré pour déterminer un taux de variation de la température intérieure, et le contrôleur (16) est en outre configuré pour ajuster la valeur de correction quand le taux de variation déterminé de la température intérieure de véhicule est supérieur à une valeur intérieure de véhicule prédéterminée.

6. Système d'air conditionné d'un véhicule selon la revendication 1, dans lequel :

la pluralité de capteurs inclut un capteur de température de liquide de refroidissement du moteur (14), et le contrôleur (16) est en outre configuré afin de déterminer si la température de surface intérieure est inférieure au point de rosée ajusté quand la température du liquide de refroidissement du moteur détectée est inférieure à une valeur de liquide de refroidissement du moteur prédéterminée.

7. Système d'air conditionné d'un véhicule selon la revendication 1, dans lequel :

le contrôleur (16) est en outre configuré afin de compter le temps ; et le contrôleur (16) arrête d'ajuster le point de rosée quand un temps prédéterminé s'est écoulé.

8. Système d'air conditionné d'un véhicule selon la revendication 7, dans lequel le contrôleur (16) diminue le temps prédéterminé à mesure que la température d'air ambiant extérieur augmente.

9. Procédé de désembuage d'une vitre de fenêtre de véhicule, le procédé comprenant:

déterminer une température d'un intérieur du véhicule ;
déterminer un point de rosée sur la base de la température déterminée de l'intérieur du véhicule ;
déterminer une température de surface intérieure d'un pare-brise (17) ;
ajuster le point de rosée ou la température de surface intérieure sur la base d'une valeur de correction ;
comparer la température de surface intérieure au point de rosée ;
effectuer une opération de désembuage quand la température de surface intérieure est inférieure au point de rosée, dans lequel le point de rosée ou la température de surface intérieure est une valeur ajustée ; et
caractérisé en ce que la valeur de correction est basée au moins partiellement sur une différence entre une

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résistance thermique du pare-brise (16) et une résistance thermique d'une vitre de porte de véhicule.

10. Procédé de désembuage d'une vitre de fenêtre de véhicule selon la revendication 9, dans lequel l'opération de désembuage comprend au moins une étape consistant à :

5
ajuster la température de l'intérieur du véhicule ;
changer un mode de conditionnement d'air en un mode de dégivreur ;
augmenter une vitesse de rotation d'un ventilateur de soufflerie pour augmenter une quantité de rendement
provenant d'une pluralité d'événements de dégivreur ;
10 augmenter une température d'air soufflé depuis la pluralité d'événements de dégivreur ;
changer une configuration d'écoulement d'air de la recirculation à l'introduction d'air ambiant extérieur ; et
souffler de l'air déshumidifié hors de la pluralité d'événements de dégivreur.

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FIG.1

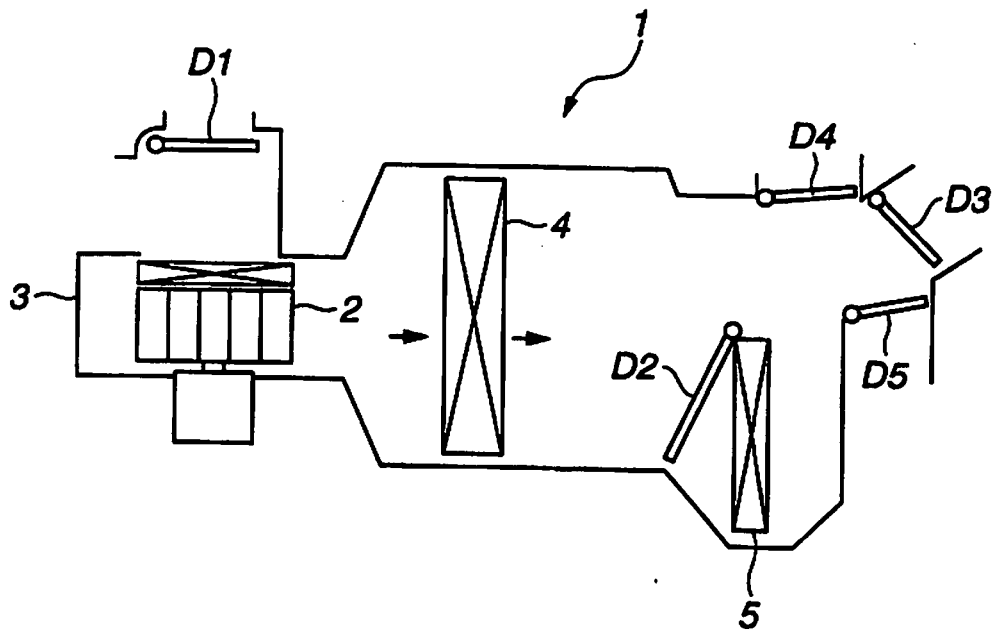


FIG.2

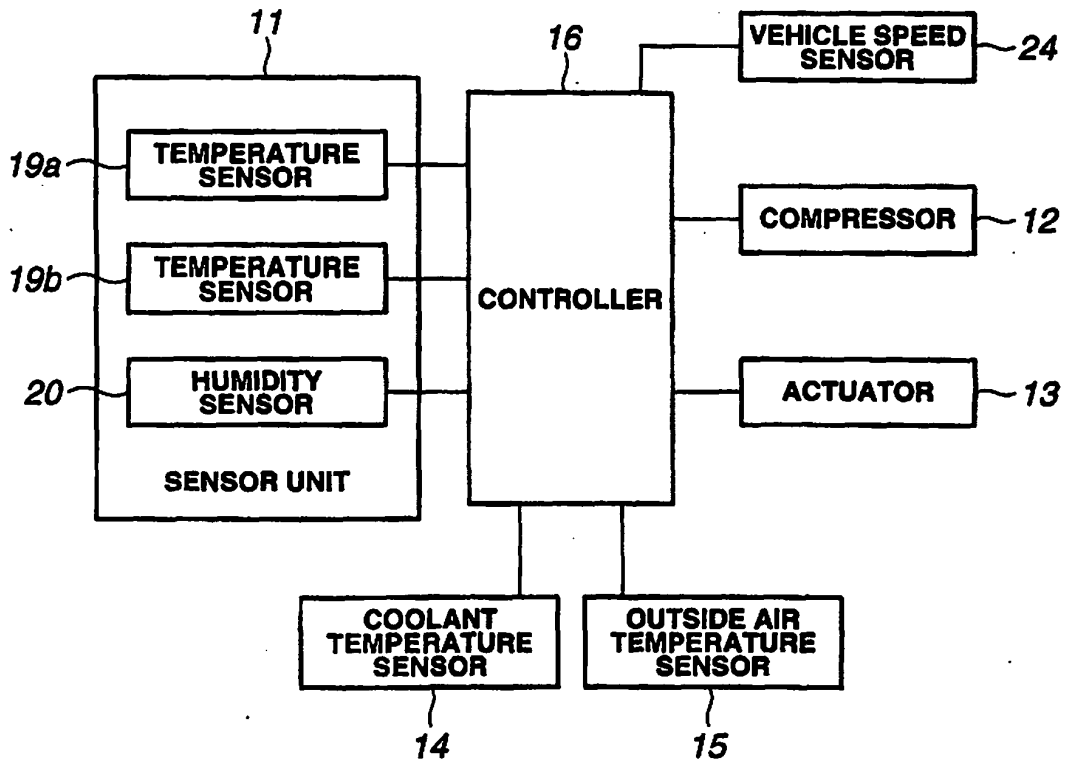


FIG.3A

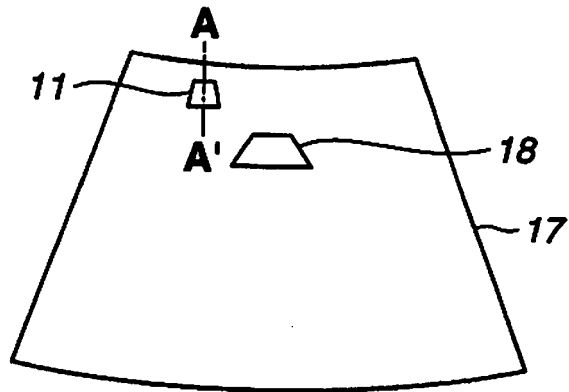


FIG.3B

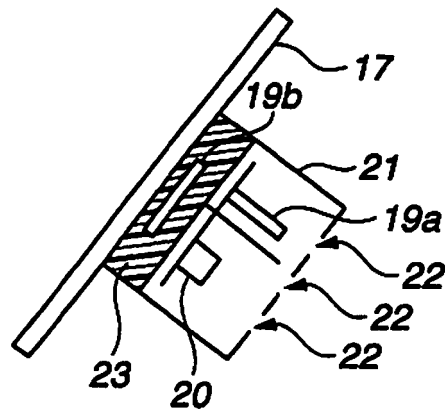


FIG.4

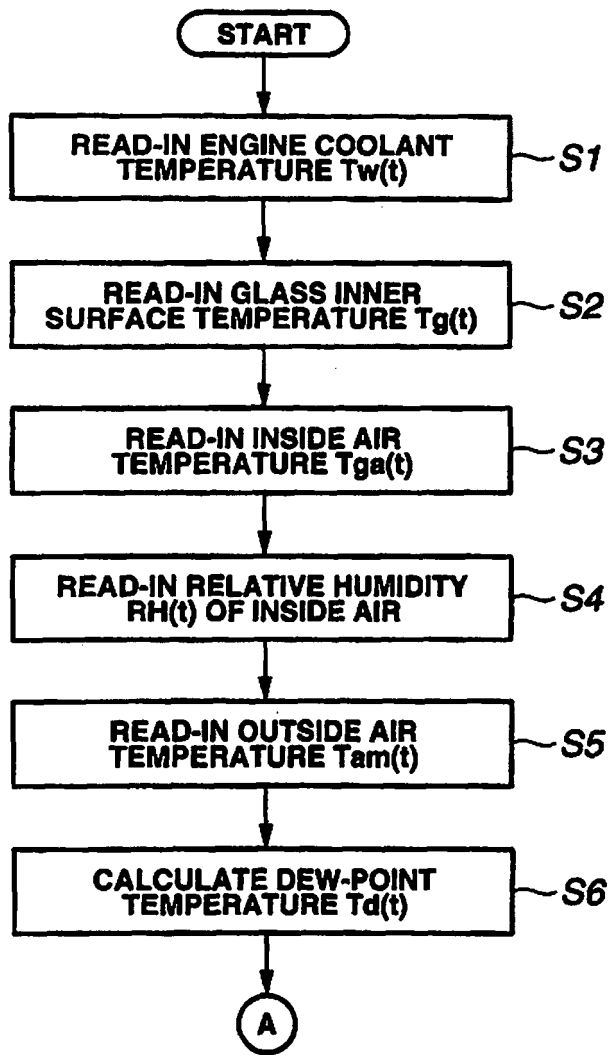


FIG.5

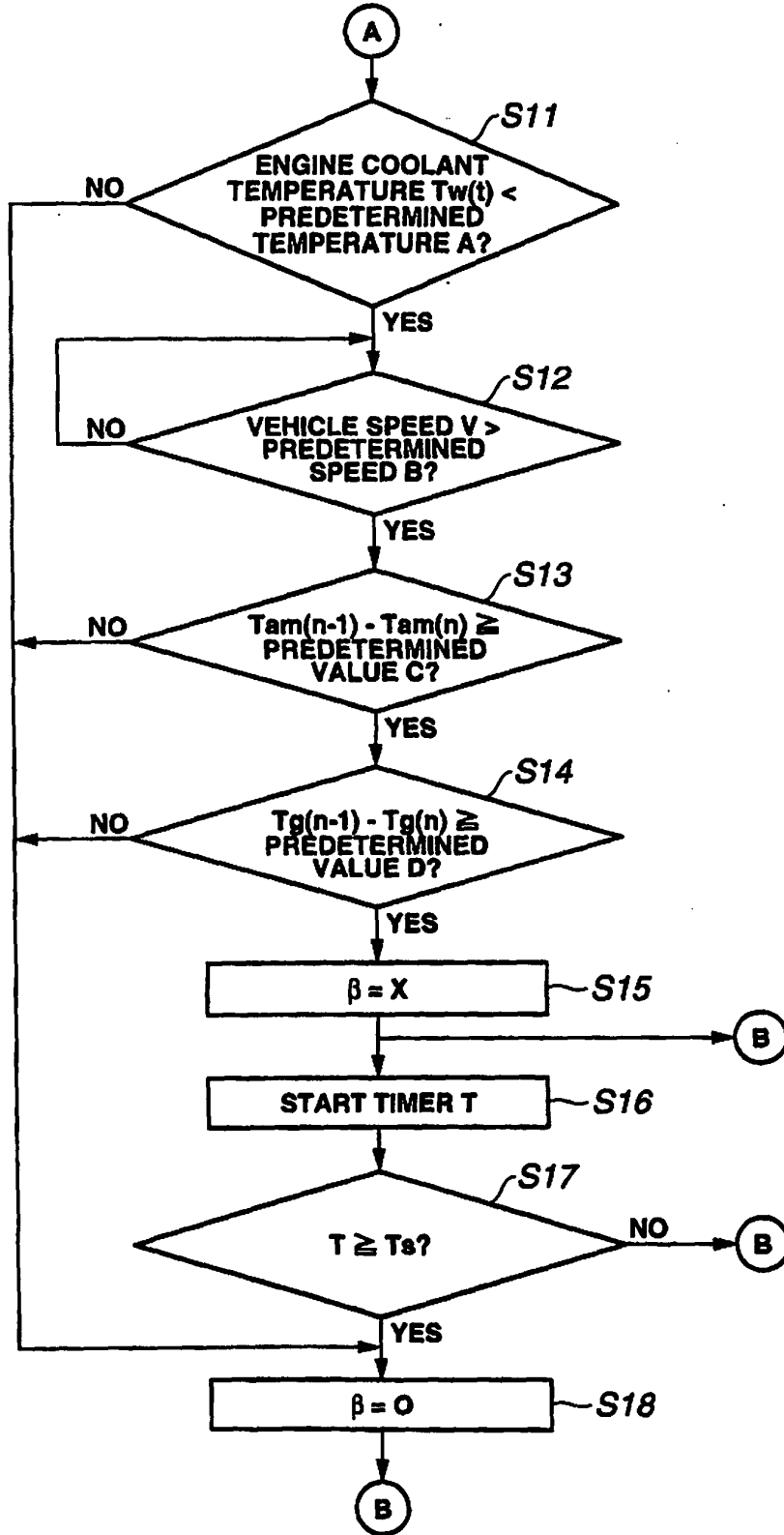


FIG.6

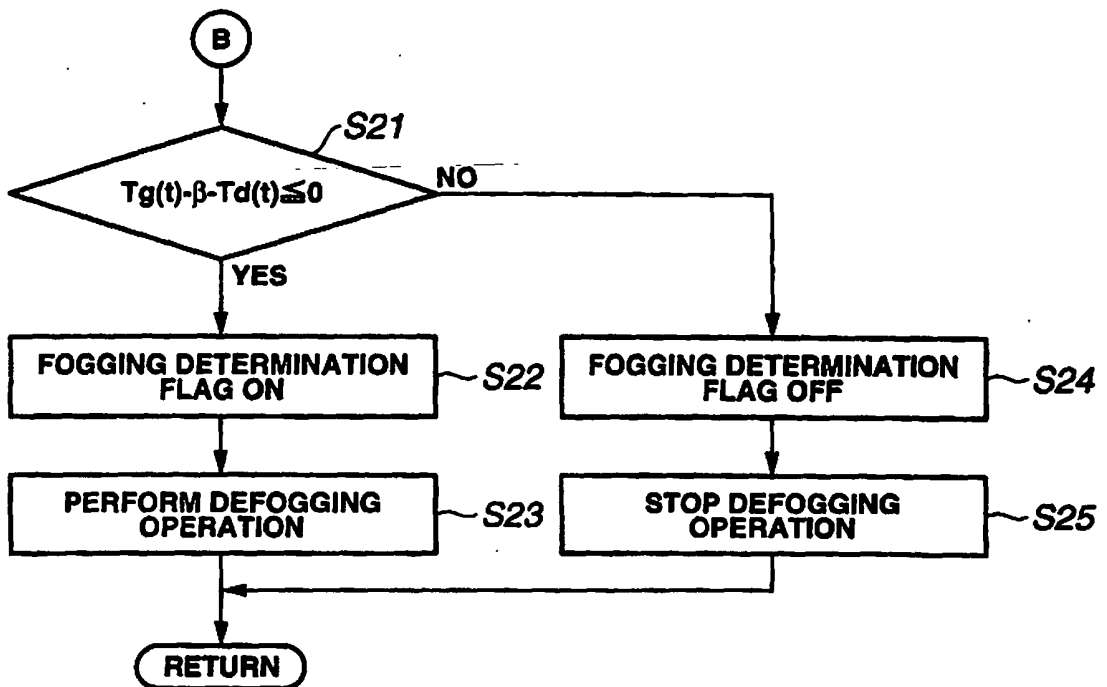
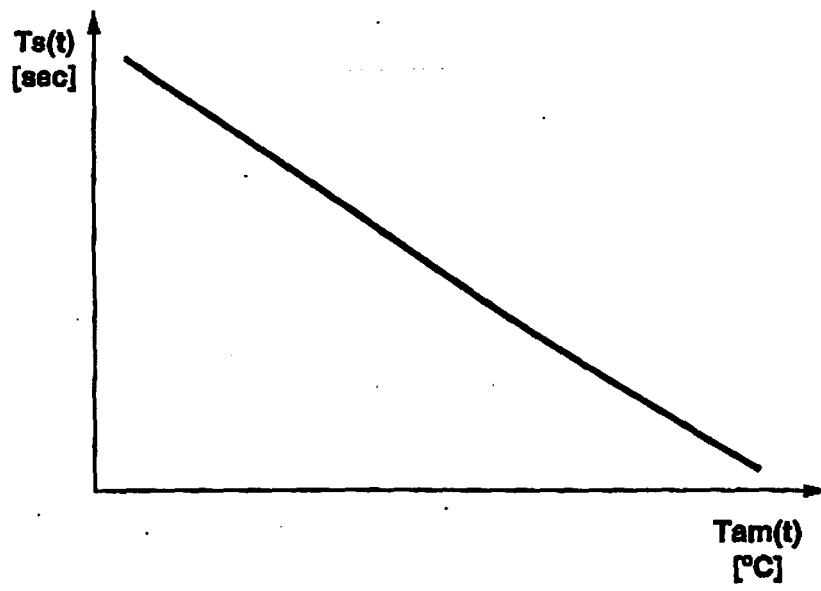


FIG.7



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 7232549 A [0002]
- US 20060289458 A [0002]